TEXAS DEPARTMENT OF HEALTH

AUSTIN, TEXAS 00-127

INTER-OFFICE MEMORANDUM

TO: Regional Directors
Directors, Local Health Departments
Directors, Independent WIC Local Agencies
Herman Horn, Chief, Bureau of Regional/Local Health Operations

FROM: Barbara Keir, Director
Division of Public Health Nutrition and Education
Bureau of Nutrition Services

DATE: December 1, 2000

SUBJECT: Formula Conference Call
December 12, 2000
Topic: Human Milk Fortifiers

The next formula conference call is scheduled for December 12, 2000. The main topic of the conference call will be **Human Milk Fortifiers for Premature Infants.** Attached you will find the written text for this discussion. Please copy and distribute to appropriate staff. There will be no transcript for this conference call. These notes are intended to substitute for the transcript. We highly recommend that these notes are read prior to the conference call to enhance the information that will be provided. This session will be audio taped and the tape will be available upon request.

To connect to the conference call on December 12, 2000, dial (512) 463-1928. Then enter: 1501518# (Don't forget to enter the pound sign at the end.)

Projects # 1 - 53 Assigned to 10:00 - 11:30 time slot
Projects #54 -106 Assigned to 12:00 - 1:30 time slot

If this time interferes with local agency plans, please let us know and we will move you to the other time slot. We are limited in the numbers for each time slot, so please let us know as soon as possible. If you have any questions, please feel free to contact Roxanne Robison, Children with Special Health Care Needs Nutrition Consultant at (512) 4587111 extension 3495, or Patti Fitch, Clinical Nutrition Coordinator at (5 12) 4587111 extension 3598. You may order tapes from Fran Manor at (512) 458-7111 extension 2126.

Attachment: Human Milk Fortifiers

Use of Human Milk and Human Milk Fortifiers for Preterm Infants

Human Milk

Human milk from the mother who delivers a preterm infant is usually the feeding of choice for infants born prematurely. The advantages of feeding the premature infant human milk include:

- A lower rate of infection compared with those fed infant formula. Preterm colostrum contains significantly higher levels of sIgA and other anti-infective properties than does full-term colostrum. A lower rate of infection has been reported for sepsis, meningitis, RSV, rotovirus, and urinary tract infections, to which the preterm infant is especially vulnerable. This lower rate of infection occurs when either fresh or pasteurized human milk is fed.

- A decreased risk for developing necrotizing enterocolitis (NEC). Lucas and Cole (1990) found that NEC was 6 to 10 times more likely to develop in exclusively formula-fed infants than in those infants fed only human milk. Infants receiving human milk supplemented with commercial infant formula were 3 times more likely to develop NEC than were the infants who were fed human milk exclusively. Human milk may protect against NEC by coating the intestine with IgA and providing growth factors and hormones which speed the development of the gastrointestinal tract.

- Human milk contains hormones and growth factors specific to human milk which help speed the development and function of organ systems such as the respiratory, nervous, and gastrointestinal systems.

- Enzymes found in human milk help with digestion and absorption of nutrients such as iron, zinc, and fat. This is especially important in preterm infants who are born with low levels of bile salts and pancreatic lipase. One study showed that infants under 1500 grams absorb 90% of human milk fat but only 68% of fat found in cow's milk-based formula.

- Human milk is well tolerated and helps the infant to achieve full enteral feedings sooner than infants who are fed commercial infant formula designed for premature infants. This holds true when either mother's own milk or donor human milk is fed.

- Fatty acids in breastmilk, such as docosahexanoic acid (DHA) and arachidonic acid (AA), are present in human milk and are not affected by pasteurization, are known to improve visual acuity in premature infants. The incidence and severity of retinopathy of prematurity has been shown to be significantly less in premature infants fed human milk versus infants fed commercial infant formula developed for premature infants.

- Possible improvement in neurological and cognitive development.

- Many mothers report psychological benefits from expressing breastmilk for their preterm infant. It is a contribution to their infant's care that only the mother can make. This is especially important because most of the infant's care is provided by the neonatal intensive care unit staff. In addition to psychological benefits, exposure of the mother to the environment of the neonatal nursery and through skin-to-skin contact with her premature infant may induce her to make specific antibodies against pathogens in the nursery. These antibodies can be passed on to her infant through her milk.

Although the feeding of human milk has distinct advantages over feeding formulas designed for premature infants, the exclusive feeding of unfortified human milk in infants with birth weights less than 1500 grams (3 lb 5 oz) has been associated with poorer rates of growth and nutritional deficits beyond the period of hospitalization. Inadequate amounts of protein, calcium, phosphorus, sodium, vitamins, zinc and energy are found in premature infants who are fed unfortified human milk.

Mature Human Milk versus Preterm Human Milk

Milk from mothers of preterm infants, especially during the first two weeks after delivery, contains higher concentrations of some nutrients but slightly lower concentrations of others. A comparison of the differences in composition between preterm human milk and mature human milk is shown in **Table 1.** The higher protein content of preterm milk may be sufficient to match the fetal growth requirement during the first 2 to 3 weeks of life, however, by the end of the first month of life the protein content of preterm mik is inadequate to meet the needs of most preterm infants, as are calories and several vitamins and minerals. It has been well established that continued use of human milk for longer periods will result in low levels of blood sodium by 4 to 5 weeks, low protein by 8 to 12 weeks, osteopenia by 4 to5 months, and a zinc deficiency by 2 to **6** months of age. **Osteopenia and rickets** are conditions that may develop in premature infants from inadequate intake of calcium and phosphorus from being fed unfortified human milk. Not all premature infants fed human milk develop rickets. In fact, it is uncommon above a birth weight of 1500 grams. However, the VLBW infant (<3lb. 5 oz.) does need supplementation, and cases of rickets are well documented in this population.

Human Milk Fortification

Indications for Use

Human milk fortifiers are indicated for:

- Infants <34 weeks gestation
- Infants <1500 grams at birth
- Infants on suboptimal parenteral calcium and phosphorus for more than two weeks prior to starting enteral feedings

Very low birth weight (VLBW) infants fed human milk exclusively following discharge from the intensive care nursery are at risk for mineral deficiencies. At discharge, an infant whose birth weights was <1500 grams (3 lb. 5 oz) and whose discharge weight is less than 2000 grams (4 lb. 6 oz.) may benefit from continued fortification of human milk or supplementation with premature infant formulas or modular supplements in addition to breastmilk. Other infants, such as those with congenital heart disease or bronchopulmonary dysplasia, or those requiring fluid restriction may also benefit from fortified human milk beyond 2000 grams.

Types of Human Milk Fortifiers

Nutrient fortification of human milk can be accomplished by adding liquid or powdered fortifiers, premature infant formulas or vitamin/mineral supplements to human milk. All human milk fortifiers contain fat soluble vitamins and all contain the minerals calcium, phosphorus, magnesium, sodium, potassium, and chloride. Most fortifiers contain some combination of water soluble vitamins. There are three commercially available human milk fortifiers currently on the market in the United States. **Enfamil Human Milk Fortifier** (Mead Johnson) and **Similac Human Milk Fortifier** (Ross) are powdered fortifiers available in unit dose packets. Similac Natural Care is a liquid human milk fortifier. **Table** 2. shows the nutrient comparison of Enfamil HMF and Similac HMF. Mixing one packet to 25 mls. of human milk will yield 24 calories per ounce of human milk. Using one packet of fortifier to 50 mls. of human milk yields 22 calories per fluid ounce. Human milk fortifier should not be added to mother's milk that has been expressed during the first two weeks after delivery, as this milk is already rich in nutrients. Powdered human milk fortifiers work well when the mother has an adequate milk supply.

Similac Natural Care (Ross) is a liquid 24 calorie per ounce human milk fortifier that can be mixed with any ratio of human milk or fed full strength as a supplement to breastfeeding or expressed breastmilk. Many mothers of premature infants do not have an adequate milk supply after pumping for an extended period of time. The use of a liquid fortifier can help to extend the mother's milk supply. The nutrient composition of Similac Natural Care is similar to that of the premature infant formula, **Similac Special Care** 24 **low iron,** with the exception of calcium and phosphorus, which are increased in Similac Natural Care. An iron supplement is usually required when Similac Natural Care is used.

Table 3. shows the nutrient comparison of mature preterm human milk compared to mature preterm human milk with selected human milk fortifiers and the premature infant formulas, Enfamil Premature 24 and Similac Special Care 24.

Problems with Human Milk Fortifiers

The ideal human milk fortifier is one that allows the infant to receive all the benefits of human milk with the added benefit of the extra nutrients needed to achieve optimal growth and nutrient accretion. Some of the problems with human milk fortifiers in the past have been lower rates of

fat absorption, and therefore calorie intake, in infants fed fortified human milk compared to infants fed formulas designed for premature infants. In fact, premature infants fed preterm infant formulas have better rates of growth than infants fed fortified human milk. Infants fed fortified human milk, on the other hand, have shorter hospital stays, less infection and NEC than infants fed preterm formula. The high content of minerals in the human milk fortifiers are thought to adversely affect fat absorption. However, studies show that bone mineralization does not differ between those fed fortified human milk versus those fed preterm formulas. The new Similac Human Milk Fortifier and the newly reformulated Enfamil Human Milk Fortifier now contain some fat in the form of MCT oil, which may allow for better fat absorption.

When human milk has added fortifiers, bacterial counts in the milk will increase over time when maintained at room temperature. Fortifiers should be added as close to a feeding time as possible with prompt refrigeration of unused milk.

Human Milk Fortifiers Post Hospital Discharge

Enfamil Human Milk Fortifier and Similac Human Milk Fortifier are usually not necessary once the infant reaches a weight of 2000 grams to 2500 grams (4# 6 ozs to 5 ½ lbs.). Milk volumes greater than 400 mls/day (13 ozs) require 16 packets of human milk fortifier and provide the infant with significant and perhaps excessive amounts of protein, vitamins, and minerals. This is the normal intake volume of an infant who weighs 2000 to 2500 grams. Similac Natural Care can be used to fortify or supplement human milk until the infant reaches a weight of 8 Ibs. (3600 grams).

When ELBW and VLBW infants are discharged to home, they typically weigh approximately 1700 to 2500 grams (3 ¾ lbs. to 5 ½ lbs.). Total breastfeeding supplemented with a pediatric multivitamin with iron does not provide the recommended intakes of protein, sodium, calcium, phosphorus, magnesium, zinc, and folic acid. Supplementation of breast milk a human milk fortifier, premature infant formula, or step down premature infant formula after discharge is therefore necessary to achieve recommended nutrient intakes.

Hypophosphatemia (low phosphorus level in the blood) is a sensitive indicator of low bone mineralization in the VLBW infant. Weekly measurements of serum phosphorus for the first month and biweekly until the infant weighs 2000 grams is recommended. A level below 4 mg/dl should be followed by x-ray of the wrists for osteopenia and rickets. Calcium levels should also be checked weekly, as levels above 11 mg/dl should be evaluated for too much calcium or too little phosphorus.

One method is to supplement half the daily volume as premature infant formula e.g., Similac Special Care or Enfamil Premature 24, which allows the ELBW or VLBW infant to better achieve recommended nutrient intakes. Similac Special Care and Enfamil Premature infant formulas should be discontinued once the infant reaches the weight of 8 lbs. or 5 ½ lbs.,-4-4

respectively. The additional nutrients will help support continued need for catch-up growth. VLBW infants fed unsupplemented human milk after discharge have been found to develop low phosphorus levels, indicative of poor bone mineralization, and lower protein status compared to similar infants who received a more nutrient-dense post discharge feeding. For the larger premature infant, who weighs more than 2500 grams at discharge, **Similac NeoSure** or **Enfamil EnfaCare** formulas can be used as a powdered human milk fortifier, as shown in **Tables 4 and** 5, or as a supplement to breastfeeding for the mother with an inadequate milk supply. **Tables 6 and** 7 show the nutrient composition of human milk using NeoSure and EnfaCare as human milk fortifiers at various caloric concentrations.

Table 1. Selected Nutrient Comparison of Preterm Human Milk and Mature Human Milk

Nutrients		Preterm Human Milk	Mature Human Milk
Energy	Calories	100	100
Volume	ml	150	147
Protein	grams	2.4	1.5
Fat	grams	5.3	5.7
Carbohydrate	grams	11	10.7
Calcium	mg	38	41
Phosphorus	mg	22	21
Magnesium	mg	5.0	5.1
Iron	mg	0.14	0.03
Zinc	mg	0.56	0.18
Manganese	mcg	0.5	1.0
Copper	mcg	57	37
Iodine	mcg	27	16
Sodium	mg	44	26
Potassium	mg	74	77
Chloride	mg	89	62
Vitamin A	IU	72	328
Vitamin D	IU	12	3
Vitamin E	IU	0.6	0.5
Vitamin K	mcg	3.0	0.3

Table 2. Comparison of Enfamil Human Milk Fortifier and Similac Human Milk Fortifier

	Enfamil HMF	Similac HMF
Calories (per 4 packets)	14	14
Protein, grams	1.1	1.0
Fat, grams	0.65	0.36
Carbohydrate, grams	1.1	1.8
Vitamins:		
Vitamin A, IU	950	620
Vitamin D, IU	150	120
Vitamin E, IU	4.6	3.2
Vitamin K, ug	4.4	8.3
Thiamin, ug	150	233
Riboflavin, ug	220	417
Vitamin B6, ug	115	211
Vitamin B12, ug	0.18	0.64
Niacin, ug	3000	3570
Folic acid, ug	25	23
Pantothenic acid, ug	730	1500
Biotin, ug	2.7	26
Vitamin C, mg	12	25
Minerals:		
Calcium, mg	90	117
Phosphorus, mg	45	67
Magnesium, mg	1	7
Iron, mg	1.44	0.35
Zinc, mg	0.72	1
Manganese, ug	10	7.2
Copper, ug	44	170
Sodium, mg	11	15
Potassium, mg	20	63
Chloride, mg	9	38

Table 3. Nutrient Comparison of Preterm Human Milk (PHM) and PHM Fortified with Enfamil Human Milk Fortifier (EHMF), Similac Human Milk Fortifier (SHMF), Similac Natural Care (SNC), and Selected Formulas for Premature Infants per 100 mls.

Nutrients	PHM	PHM + EHMF	PHM + SHMF	PHM + SNC (50:50)	Enfamil Premature 24	Similac Special Care 24
Calories	66.4	79.2	79.2	74	81.2	80.6
Protein, g	1.6	2.7	2.6	1.8	2.4	2.18
Fat, g	3.54	4.1	3.8	4.14	4.1	4.37
Linoleic, mg	480	562	473		900	564
Linolenic mg	30	40	30		130	
CHO, g	7.25	8.2	8.9	7.62	9.0	8.54
Vitamin A, IU	48	983	658	700	1010	1008
Vitamin D, IU	8	156	126	61.4	220	121
Vitamin E, IU	0.42	4.9	3.6	4.14	5.1	3.22
Vitamin K, ug	1.99	8.2	10.1	5.18	6.5	9.67
Thiamin, ug	8.90	157	238	111	162	201
Riboflavin, ug	26.6	233	437	274	240	500
Vitamin B6 ug	6.2	119	214	108	122	201
Vitamin B 12, ug	0.02	0.20	0.65	0.24	0.25	0.44
Niacin, mg	0.2	3.2	3.7	2.22	3.2	4.03
Folic Acid, ug	3.05	28	26	16.28	28	30
Pant. Acid, mg	0.23	0.9	1.7	.8	1.0	1.53
Biotin, ug	0.54	3.2	26.1	15.5	3.2	29.8
Vitamin C, mg	4.35	16.1	28.9	20.7	16.2	29.8
Calcium, mg	25	114	140	97	134	145
Phosphorus,mg	15	59	80	53	67	80.6
Magnesium,mg	3.26	4.2	10.1	6.36	5.5	9.67
Iron, mg	0.09	1.50	0.4	.20	1.5	1.45
Zinc, mg	0.37	1.1	1.3	.77	1.2	1.20
Manganese, ug	0.29	10.1	7.4	5.18	0.6	9.67
Copper, ug	38	81	205	133	101	201
Sodium, mg	28	38	42	29.6	32	34.6
Potassium, mg	50	69	111	80	84	104
Chloride, mg	58	66	95	60	69	65.3
Osmolality, mOsm/kg water	275	335	360	285	310	280

Table 4

Preparation of Mature Human Milk with Similac NeoSure to Various Caloric Densities

Calories Per Fluid Ounce	Amount of NeoSure Powder	+	Ounces of Human Milk (mls)
22	1 teaspoon	+	4 ⅓ (130 mls)
24	1 teaspoon	+	2 ⅓ (70 mls)
27	1 teaspoon	+	1 ⅓ (40 mls)

Table 5

Preparation of Mature Human Milk with Enfamil EnfaCare to Various Caloric Densities

Calories Per Fluid Ounce	Amount of EnfaCare Powder	Ounces of Human Milk (mls)
22	⅓ tsp, packed	1 ½ oz. (45 mls)
24	½ tsp, packed	1 ½ oz. (45 mls)
27	1 tsp, packed	1 ½ oz. (45 mls)

Table 6. Estimated Nutrient Content of Term Human Milk (HM) + NeoSure Powder per 100 mls. at Various Caloric Concentrations

Nutrients	Term HM	Term HM + NeoSure 22 kcal/oz	Term HM + Neosure 24 kcal/oz	Term HM + NeoSure 27 kcal/oz
Calories	68	76	82	93
Protein, grams	1	1.3	1.4	1.7
Fat, grams	3.9	4.3	4.7	5.3
Carbohyrdrate, g	7.2	8.0	8.7	9.8
Vitamin A, IU	223	261	292	341
Vitamin D, IU	2	9	15	24
Vitamin E, IU	0.3	0.7	0.9	1.3
Vitamin K, mcg	0.2	1.2	2.0	3.2
Thiamin, mcg	21	40	56	81
Riboflavin, mcg	35	47	58	75
B 6, mcg	20	29	36	47
B12, mcg	0.05	0.08	0.11	0.16
Niacin, mcg	150	319	461	684
Folic Acid, mcg	5.0	7.2	8.9	11.7
Pantoth Acid, mcg	180	248	305	394
Biotin, mcg	0.4	1.2	1.8	2.9
Vitamin C, mg	4.1	5.3	6.4	8.1
Calcium, mg	28	37	44	56
Phosphorus, mg	14	20	24	31
Magnesium, mg	3.5	4.2	4.8	5.8
Iron mg	0.3	0.2	0.3	0.5
Zinc, mg	0.1	0.2	0.3	0.5
Manganese, mcg	0.6	1.5	2.2	3.4
Copper, mcg	25	35	44	57
Iodine, mcg	11	12.2	13.2	14.7
Sodium, mg	17.7	20.3	22.6	26.1
Potassium, mg	52.4	64.1	74	89.5
Chloride, mg	42.2	49.3	55.3	64.8

Table 7. Estimated Nutrient Content of Term Human Milk (HM) + EnfaCare Powder per 100 mls. at Various Caloric Concentrations

Nutrients	Term HM	Term HM + EnfaCare 22 kcal/oz	Term HM + EnfaCare 24 kcal/oz	Term HM + Enfacare 27 kcal/oz
Calories	68	74	81	91
Protein, grams	1.05	1.224.2	1.41	1.69
Fat, grams	3.9	4.2	4.6	5.1
Carbohydrate, gr.	7.2	7.8	8.6	9.7
Vitamin A, IU	223	250	280	330
Vitamin D, IU	2.2	7	12.6	21
Vitamin E, IU	0.31	0.55	0.83	1.23
Vitamin K, mcg	0.21	0.69	1.25	2.1
Thiamin, mcg	21	33	47	67
Riboflavin, mcg	35	47	61	81
Vitamin B6, mcg	20.5	27	34	44
Vitamin B12, mcg	0.05	0.07	0.09	0.12
Niacin, mcg	150	270	410	610
Folic Acid, mcg	5	6.6	8.4	11
Pantoth, Acid, mcg	180	230	290	380
Biotin, mcg	0.4	0.76	1.18	1.78
Vitamin C, mg	4	5	6.1	7.7
Calcium, mg	28	35	44	56
Phosphorus, mg	14	18	23	29
Magnesium, mg	3.5	4	4.5	5.3
Iron, mg	0.03	0.14	0.26	0.44
Zinc, mg	0.12	0.2	0.28	0.41
Manganese, mcg	0.6	1.5	2.6	4.1
Copper, mcg	25	32	41	53
Iodine, mcg	11	11.9	13	14.5
Sodium, mg	18	20	23	26
Potassium, mg	52.5	59	66	77
Chloride, mg	42	47	52	60